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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W., Room 222
Washington, D.C. 20554

> RE: Ex Parte Presentation
> GEN Docket No. 90-314

Dear Mr. Caton:

On September 8, 1994, Dr. Richard Roy of ArrayComm, Inc. met with representatives of the FCC's Office of Engineering and Technology and Mobile Services Division with respect to the joint petition for further reconsideration in the above-referenced proceeding filed by ArrayComm and its subsidiary, Spatial Communications, Inc. The FCC participants in the meeting were Rodney Small, Richard Engelman, Stanley Wiggins, John Reed and Sean White.

Submitted herewith are two copies of a written summary of the presentation by Dr. Roy for submission in the record.

Sincerely,

Jill Abeshouse Stern

Enclosure

No. of Copies rec'd 0+2
List ABCDE

Proposed PCS Power Limits

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presented to

FCC

8 September 1994

Broadband PCS Power Limits

1. **Introduction**

2. Current Power Limits

3. Proposed Limits

4. Examples

5. Discussion

Summary of PCS Power Limit Proposal

- Current PCS base station power limits

  - are overly restrictive, thereby limiting the value of spectrum
  - favor narrowband over broadband technologies
  - have possible loop-holes

- Proposed PCS base station power limits

  - are maximally flexible
  - treat all modulation formats equally
  - encourage the development of new technologies
  - guarantee a measure of public safety
  - compliance is more easily measured

- Basic concept: replace "per carrier" in the current definition with "per Hertz" of allocated bandwidth

PCS Power Limit Principles

- **Maximize the value ($) of spectrum by:**

  o **promoting development of new cost effective PCS technologies**

  o **treating narrowband and broadband technologies equally**

$$C = W \log_2\{1 + \frac{P}{N}\}$$

- **Guarantee:**

  o **public safety through acceptable worst case limits**

  o **equal opportunity for all by setting interference limits**

Summary of Replies to Comments

- Motorola and MCI generally supported the proposal (thank you for your support)

- Northern Telecom

  o supported the clarification on base station transmitters (welcome, but unlikely to pass)

  o suggested proposed change from "per carrier" to "per Hertz" might be a bit too complicated (actually it is simpler)

- Sprint

  o did not comment on the clarification on base station transmitters

  o suggested since SDMA was independent of modulation format, SDMA would not be disadvantaged by a rule favoring narrowband over broadband technology (correct!... the proposal does not favor SDMA ... it helps broadband compete on equal footing with narrowband technologies)

  o is correct that the current rules do not unfairly disadvantage SDMA (smart antennas are here to stay ... the objective is to provide maximum flexibility to develop economically viable PCS systems!)

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Current PCS Power Limits

- **PCS base station transmission power is limited to:**

  - **1640 W EIRP for antenna HAATs less than 300m where EIRP is defined "per (RF) carrier"**

  - **100 W transmitter power amplifier output "per carrier" at each "base station"**

- **PCS mobile unit power is limited to 2W EIRP**

- **Out-of-band interference regulated**

- **OFS in-band interference regulated (TSB-10E/F guidlines employed)**

ARRAYCOMM

Current PCS Power Limits

- **Potential problems with current limits:**

  - ○ **"per carrier" is a modulation format dependent unit**

  - ○ **125 10 kHz (NAMPS) carriers can transmit 125 times more power (205 kW) than 1 1.25 MHz (CDMA) spread spectrum carrier at each "base station" $\Longrightarrow$ much greater information carrying capacity ... (public safety not guaranteed and narrowband technologies are favored)**

  - ○ **"omni-directional" broadcast control channels (required in all systems) are unnecessarily restricted in coverage range ... thus limiting all systems**

- **Problems stem from overly restrictive nature of the rules**

- **Proposed solution: change "per carrier" to "per Hertz"**

ARRAYCOMM

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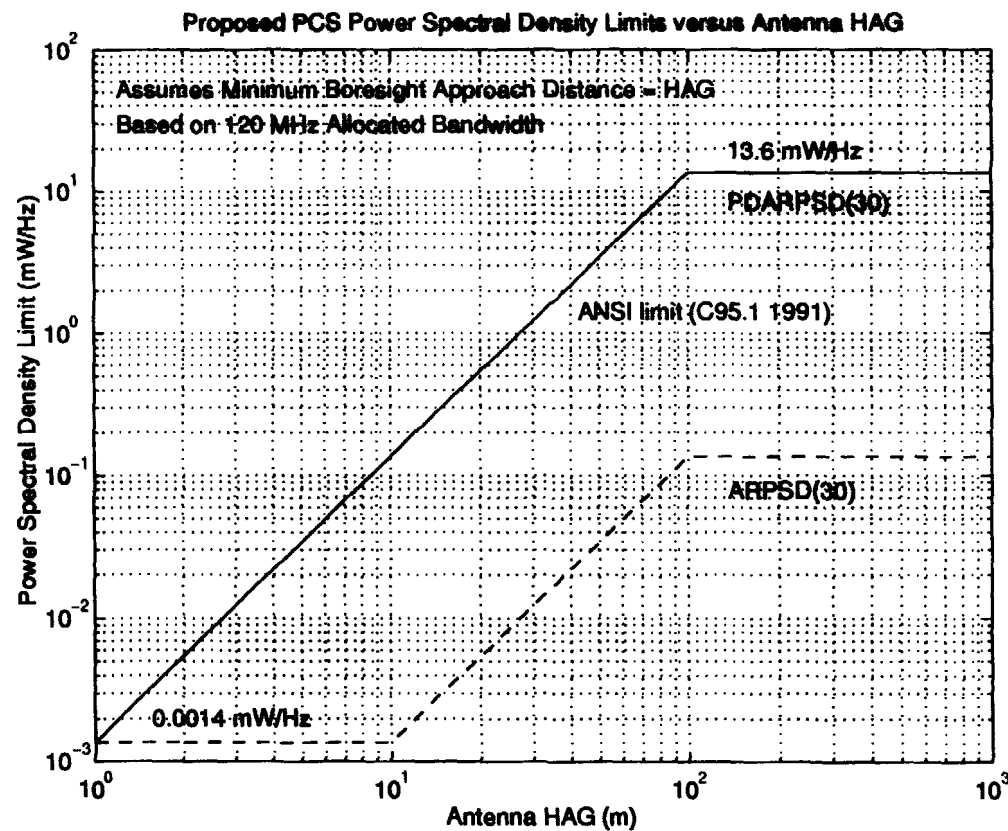5. Discussion

ARRAYCOMM

Proposed PCS Power Limits

- **Objectives of Proposed Power Limits**

  - **maximum flexibility to**

    - **promote development of new spectrally efficient technology, but not deter economical deployment of current technology**

    - **ensure faster and more economical deployment of PCS systems**

    - **substantially increase the value of the spectrum allocated**

  - **treat all modulation formats (CDMA,TDMA,FDMA) equally**

  - **ensure public safety under worst possible conditions**

  - **setup good neighbor policy governing out-of-band interference and coexistence policy for in-band OFS**

Proposed PCS Power Limits

Proposed Power Limits versus Antenna Height

Proposed PCS Power Spectral Density Limits versus Antenna HAG

Assumes Minimum Boresight Approach Distance = HAG
Based on 120 MHz Allocated Bandwidth

13.6 mW/Hz
PDARPSD(30)
ANSI limit (C95.1 1991)
ARPSD(30)
0.0014 mW/Hz

Power Spectral Density Limit (mW/Hz)

Antenna HAG (m)

Proposed PCS Power Limits

- **Peak Directional Average Radiated Power Spectral Density versus Antenna Height**

$$\textbf{PDARPSD(30) in (mW/Hz)} = \begin{cases} 4\pi S h^2/\textbf{AFB}_{total}; & h \le 100 \textbf{ meters}, \\ 13.6; & h > 100 \textbf{ meters}. \end{cases}$$

where

$h =$ **antenna height above ground in meters,**

$S = f/0.15;$ **ANSI exposure limit in mW/m^2,**

$f = 1920;$ **center frequency in MHz,**

$\textbf{AFB}_{total} = 120\ MHz;$ **the total PCS allocation,**

and **PDARPSD(0) shall be limited to 10 times PDARPSD(30).**

Proposed PCS Power Limits

- Average Radiated Power Spectral Density versus Antenna Height

$$\text{ARPSD(30) in (mW/Hz)} = \begin{cases} \text{PDARPSD(30)}/100; & h \geq 10 \text{ meters}, \\ 0.0014; & h < 10 \text{ meters}, \end{cases}$$

and ARPSD(0) shall be limited to 10 times ARPSD(30).

Proposed PCS Power Limits

- Operators are allowed to transmit power in proportion to the total amount of spectrum they buy (or are allocated).

- Measuring compliance with the specifications:

  o ARP: measure total power in allocated bandwidth with power meter (peak and 30 second averages) and all channels ON ... easier than current rules!

  o PDARP: multiply ARP by specified antenna gain

  o Out-of-band Interference: must comply with current specifications

  o OFS Interference: PCS operator must comply with current specifications (TSB-10E/F)

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Proposed PCS Power Limits

Sample PCS Base Station Power Calculations

- Having guaranteed public safety in the worst case, can mobiles and base stations communicate economically?

- Consider a conventional 200 kHz bandwidth "carrier" with balanced links

  o Assume 30MHz allocation and 22 dBi antenna gain (G=160)

  o ARP(30) limit from proposed specs $\Longrightarrow$ 1.2 kW at 54 m HAAT

 o Assume link is balanced at 1.6 kW base station EIRP (per carrier):

$$\frac{1.2kW \times 160}{1.6kW} \Longrightarrow 120 \text{ carriers per base station}$$

  o PDARP(30) of 120 kW $\Longrightarrow$ 75 carriers per base station which would be the limit (thus safety considerations limit the number of channels to 75)

  o Get 1.6 kW EIRP / 8 voice channels = 200 W per voice channel

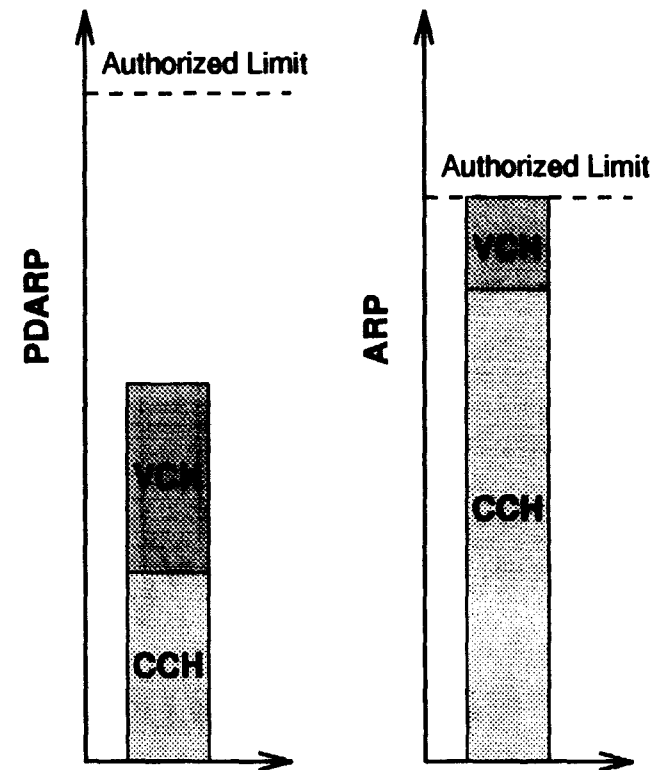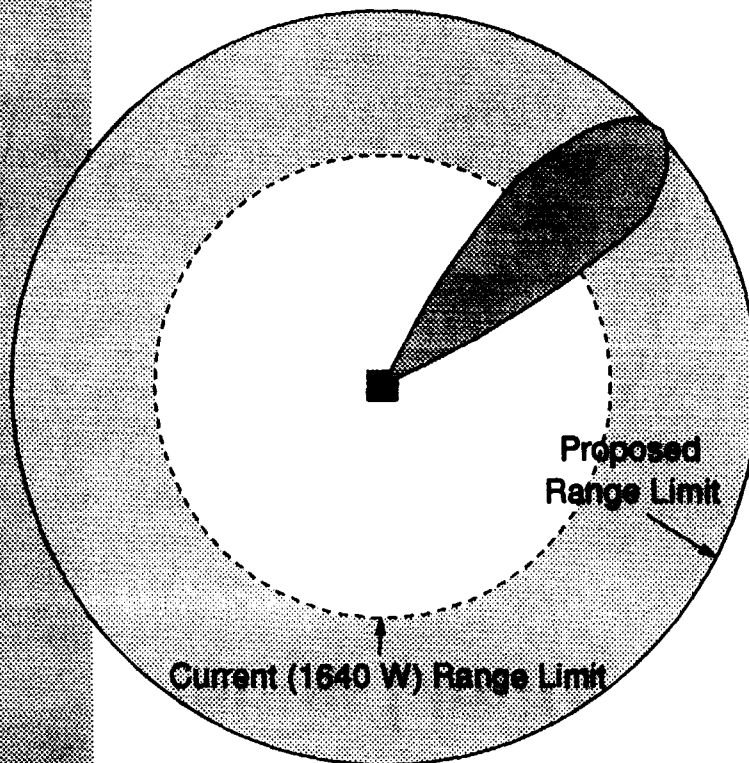 o Have $8 \times 75 = 500$ voice channels per base station

Current PCS Power Limits

Range Limits Under Current Rules
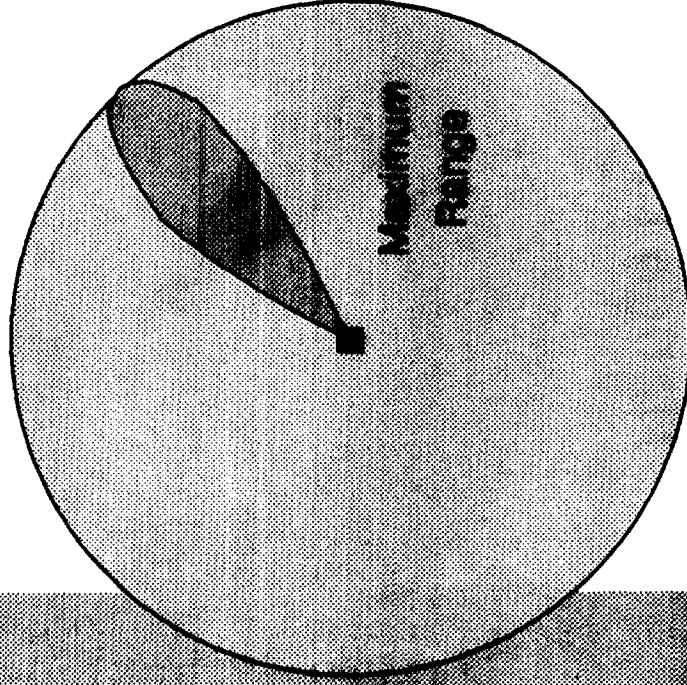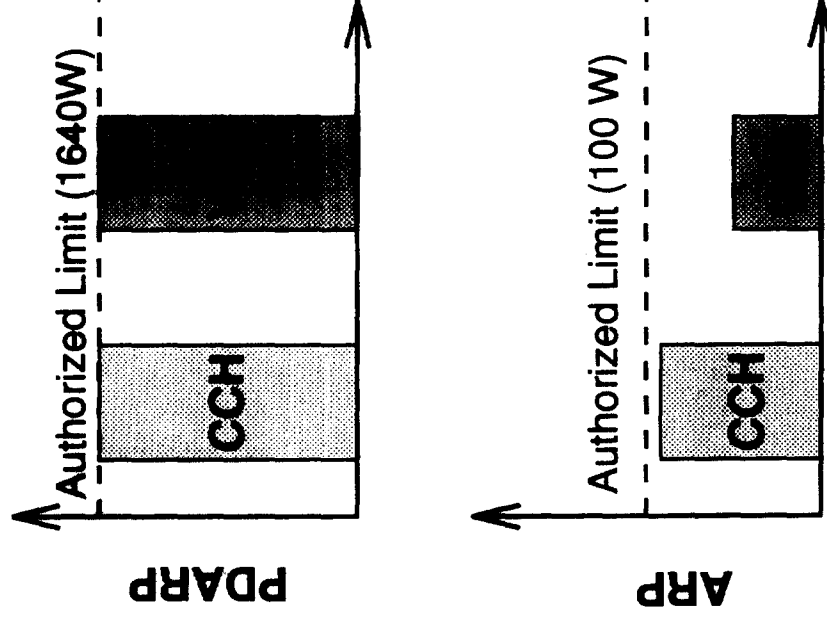
Proposed PCS Power Limits

Range Limits Under Proposed Rules

Note: These are not the same vertical scale

Proposed PCS Power Limits

Sample PCS Base Station Power Calculations (cont)

- Now consider the "control channel" (CCH)

  o Assume an omni CCH antenna with 12 dBi elevation gain ($G = 16$)

  o Current rules limit power to 1.6 kW EIRP and the maximum range follows

  o For non-CCH "smart antenna" gain of 22dBi (assuming equal EIRP CCH and non-CCH carriers), proposed rules allow for cells four times larger than current rules:

No. Non-CCH Carriers	CCH Power	Range Increase ($\gamma = 3.2$)
0	19.2 kW	2.2
1	17.5 kW	2.1
2	16.0 kW	2.0

- uplink would require about 32dBi relative gain ... (some combination of low NF, coding and spatial processing gains)

Proposed PCS Power Limits

Sample PCS Base Station Power Calculations (cont)

- Consider a 1.25 MHz bandwidth "carrier"

  o Assume 30MHz allocation and more than 20dB antenna gain

  o PDARPSD(30) limit from proposed specifications $\implies$ 120 kW at 54 m HAAT

  o Assume 12 1.25 MHz channel pairs in a 30 MHz allocation, 3-cell reuse, and 40 voice channels per "carrier"

  o Current rules limit power to 1.6 kW EIRP (per carrier) $\implies$ 40 W / voice channel

  o Proposed rules allow much large cells:

  $$120kW/4 \text{ carriers}/40 \text{ voice channels per carrier} \implies 750W/\text{voice channel}$$

  o Have $4 \times 40 = 160$ voice channels per base station

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